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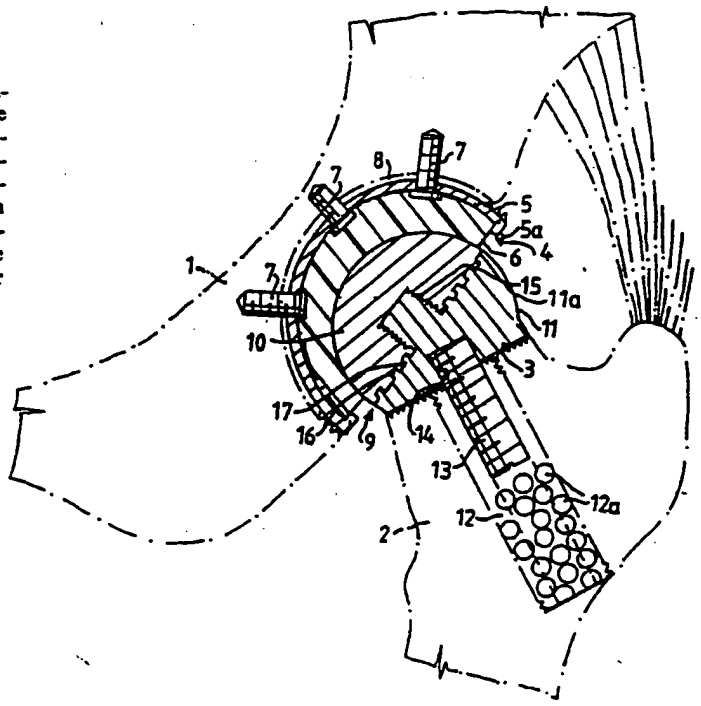
(54) Title: ARTIFICIAL HIP-JOINT

(57) Abstract

Hip joint or coxa prosthesis comprises a socket (5) and a ball (10). The socket is snapped into a socket shaped titanium holder (5), which is screwed securely into the pelvis (3). The ball is secured via a wedge shaped plate (11) to an externally and internally threaded titanium tube (12) which is screwed into a bore axial to the head and neck of the femur (2).



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ARTIFICIAL HIP JOINT

The present invention relates to a hip joint or coxa prosthesis, comprising a joint socket with anchoring means for fixing the joint socket to a pelvic bone and a joint ball with anchoring means for fixing the ball to a sectional surface of a femur, the ball of which has been cut off.

In the majority of known hip joint prostheses of this kind, the joint ball is joined to a long nail or a long pin of stainless steel or vitallium, inserted far into the central femural cavity and fixed therein by means of a two-component cement. The nail or pin is subjected to great mechanical stress and fatigue fractures of the nail or pin are not uncommon. The fracture often occurs so far down in the central femoral cavity that it is not possible to reach the remaining portion of the pin from the end of the femur. In such a situation, the surgical method used to remove the pin end is to drill a hole from the side through the femur and partially into the pin. The pin is thereafter chiselled upwards a short distance, whereafter a new hole is drilled into the pin, which is chiselled up another short distance. This procedure is repeated until the pin has been forced up sufficiently far to be able to be extracted from the exposed end of the femur. Surgical procedures of this type are time-consuming, taking up to five hours, and consequently involve severe stress on the patient and the surgical team. They are of course also costly.

The purpose of the present invention is to provide a hip joint prosthesis, which is less susceptible to fracture due to fatigue, which makes it possible to more quickly and more simply than previously replace broken and worn components, and which also makes it possible to achieve in

a simple manner exact fitting of the socket and ball to each other.

This is achieved according to the invention in a hip joint prosthesis of the type described by way of introduction by virtue of the fact that the anchoring means of the ball joint comprise a tubular element made of titanium designed to be received in a bone in the femur and be integrated with the femur, that the tubular element has an internally threaded bore and that when the element has been surgically implanted, a screw is screwed into the bore and fixes the joint ball to the tubular element.

The basic difference between the invention and the previous known technology is that the latter is based on cementing an anchoring element of a material which is not biocompatible, e.g. vitallium, in the femural cavity, while the present invention is based on the idea of using a biocompatible material such as titanium in the anchoring element and inserting the element into a bore axially to the neck of the femur, so that the anchoring element becomes integrated with the femur by new growth of bone tissue. The tubular anchoring element, which is preferably provided with internal threads, can then be used to fix the joint ball quite simply by screwing the ball or an intermediate wedge shaped element joined to the ball into the tubular element which is integral with the femur. The wedge shaped element serves as a gauge block, and by varying the wedge angle, the angle between the ball and the tubular anchoring means can be varied. By having available during the operation wedges with varying wedge angles, it is possible to achieve a very exact fit of the ball in the socket. In a corresponding manner, the socket can also be made with a socket-shaped carrier of titanium which is allowed to become embedded through bone growth in the pelvis, and the socket proper is then fixed therein.

The invention will be described below in more detail with

reference to examples shown in the accompanying drawings, where

Figure 1 shows schematically a portion of a pelvis and a femur with a partially sectioned hip joint prosthesis according to the invention in its integrated implanted state,

Figure 2 shows a view corresponding to that in Figure 1 of a prosthesis in a simpler embodiment, and

Figure 3 shows a fixture for cutting off the ball of the femur.

The numeral 1 in Figure 1 generally designates a portion of a pelvic bone and 2 designates the upper portion of a femur whih has been cut so that a flat sectional surface 3 has been formed. The joint prosthesis has a socket 4 consisting of a bowl-shaped carrier 5 of titanium and a bowl-shaped polyethylene element 6 which forms the socket proper. The carrier 5 is screwed into a cavity made in the pelvis by means of five titanium screws 7 (three shown). It has external grooves 8 on its surface facing the bone for integration therewith. The ball 9 of the joint prosthesis consists of a hemisphere 10 of titanium or stainless steel and a titanium plate 11 which is wedge-shaped in longitudinal section.

In order to fix the joint ball 9 to the exposed sectional surface 3 of the femur, according to the invention an externally and internally threaded tube 12 is used together with a screw 13 screwed into the tube, which screw is also screwed into a threaded bore 14 in the wedge shaped plate 11, which is made in one piece with a threaded stud 15, which is in turn screwed into a threaded bore in the hemisphere 10. The wedge shaped plate 11 and the hemisphere 10 have interengaging grooves 16 and ridges 17 arranged coaxially with the stud 15 and being designed to remove some of the shear load from the screw fastening between the hemisphere 10 and the wedge plate 11.

Implantation of the joint described here is done by two operations at an interval between them of about four months. In the first surgical procedure, the bowl shaped titanium carrier 5 is screwed in place by means of screws 7 into the pelvis. During the period of integrating bone growth, the socket 6 is replaced by a 2 to 3 mm thick polyethylene bowl in order to allow the screws 7 to become embedded. During the first operation, a 16 mm diameter hole is also drilled in along the axis of the femoral head and the tube 12 is screwed into the hole. The tube 12 has an internal thread along its entire length and perforations 12a along approximately half its length, i.e. the portion which, when the components are assembled, lies beyond the screw 13. The perforations are designed to provide the best possible anchoring in the femur through bone growth.

In the second operation, the 2 to 3 mm thick provisional polyethylene socket is replaced by the socket proper 6, which can consist of porous polyethylene with open pores and be impregnated with HEALON. The bowl-shaped carrier 5 has an inwardly directed peripheral edge 5a, and the socket 6 is mounted in place by simply snapping it in behind the edge 5a.

Before the ball of the joint prosthesis with associated components is mounted on the tube 12, the head of the femur must be cut normal to the tube 12 and flush with the upper end of the tube. For this purpose, a fixture 20 is used of the type shown in Figure 2. The fixture consists of an arm 21 which is screwed into the lower end of the tube 12, a threaded stud bolt 22 screwed into the arm 21 and a plate 23 with a surface 24 parallel to the end 12b of the tube to be exposed by the cut, this surface 24 forming a reference plane in which the cut is made. The threaded stud bolt 22 permits adjustment of the plate 23 to various distances from the arm 21, thus adapting it to tubes 12 of different lengths.

After the head of the femur is cut off, a wedge plate 11 is selected appropriate to the particular anatomy of the patient. Preferably, an assortment of wedge plates is available with wedge angles of at least between 15° and 25°. In the example shown in Figure 1, the wedge angle is 20°. Other parameters than the wedge angle can be varied to achieve optimum fit between the ball and the socket, e.g. the central axis of the stud 15 and the thickness of the wedge plate 11. The wedge plate 11 is screwed securely against the cut surface 3 of the bone by means of the screw 13, which has a screwdriver groove at its lower end to permit final tightening of the wedge plate 11 against the bone surface 3. The underside of the plate 11 in contact with the surface 3 is provided with teeth or grooves to promote integration with the bone. The hemisphere 10 can be screwed onto the wedge plate 11 prior to or after the latter has been fixed to the tube. As can be seen in Figure 1, the wedge plate has on one side a spherically curved surface 11a, which forms a continuation of the surface of the hemisphere and provides an increased range of articulation.

Figure 2 shows a simpler model of a hip joint prosthesis. Details corresponding to those in Figure 1 have been given the same reference numerals as in Figure 1. The prosthesis in Figure 2 differs from that described above in that there is no wedge. Instead, the ball 10 and the screw 13 are made in one piece. At the transition between the ball and the screw 13, there is a plate 30 with a smooth transition via a neck 31 to the ball 10. This embodiment ensures sufficient articulation.

The invention provides very secure anchoring of all of the components in the hip joint and at the same time provides easy replacement of components subject to wear, e.g. the polyethylene socket and the ball.

CLAIMS

1. Hip joint or coxa prosthesis, comprising a joint socket with anchoring means for fixing the joint socket to a pelvic bone and a joint ball with anchoring means for fixing the ball to a sectional surface of a femur, the ball head of which has been cut off, c h a r a c t e r - i z e d in that the anchoring means of the joint ball (10) comprise a tubular element made of titanium designed to be received in a bore in the femur and be integrated with the femur, that the tubular element (12) has an internally threaded bore and that, when the element has been surgically implanted, a screw is screwed into a bore and fixes the joint ball to the tubular element.

2. Joint prosthesis according to Claim 1, c h a r a c t - e r i z e d in that the screw (13) holds a titanium anchoring plate (11) which is wedge-shaped in longitudinal section against the sectional end surface of the femur, and that the ball (10) is fixed to the wedge shaped anchoring plate.

3. Joint prosthesis according to Claim 3, c h a r a c t - e r i z e d in that the wedge-shaped element (11) and the ball (10) are joined to each other via a screw fastener (15) and have interengaging profiles (16, 17) designed to relieve the load of shear forces from the screw fastener.

4. Joint proshtesis according to Claim 1, c h a r a c t - e r i z e d in that the screw fastener is formed by a threaded stud (15) joined to either the wedge shaped plate (11) or the ball (10), which stud is inserted into a threaded bore in the other one of said elements, and that interengaging grooves (16) and ridges (17) are arranged in the plate and ball coaxially about the stud and bore.

5. Joint prosthesis according to one of Claims 1-4, c h a r a c t e r i z e d in that the tubular element (12) is externally threaded and is intended to be screwed into the femur.

6. Joint prosthesis according to one of Claims 1-4, c h a r a c t e r i z e d in that the tubular element (12) is perforated over that portion of its length which, when the wedge shaped anchoring plate (11) is screwed in place, lies beyond the inserted screw (13).

7. Joint prosthesis according to one of Claims 1-6, c h a r a c t e r i z e d in that the socket (4) has components (5) consisting of titanium which are intended to be integrated with the pelvic bone.

8. Joint prosthesis according to Claim 7, c h a r a c t - e r i z e d in that the socket comprises a titanium socket (5) intended to be screwed securely to and integrated with the pelvic bone, and that a polyethylene socket shaped lining (6) is fixed to the titanium socket.

9. Joint prosthesis according to Claim 8, c h a r a c t - e r i z e d in that the titanium socket (5) has inwardly directed edges (5a) behind which the socket shaped lining is snapped.

10. Device for use in cutting off the head of a femur during surgical implantation of a hip joint prosthesis in accordance with one of Claims 1-9, c h a r a c t e r - i z e d by a support (21) which can be fixed to the free end of the tubular titanium element (12), which support is joined to a fixture (23) via setting means (22), by means of which the fixture can be set co-planar with the inner tube end (12b).

11. Device according to Claim 10, c h a r a c t e r - i z e d in that the support (21) is an arm (21) which can be screwed securely to the free end of the tubular element (12), that the setting means comprise an elongated element (22) directed parallel to the tubular element and which can be fixed to the support (21) in various positions, and that the fixture is formed by a plate (23) carried by said arm and having a surface (24), which by means of the setting means can be set co-planar with the inner tube end (12b).

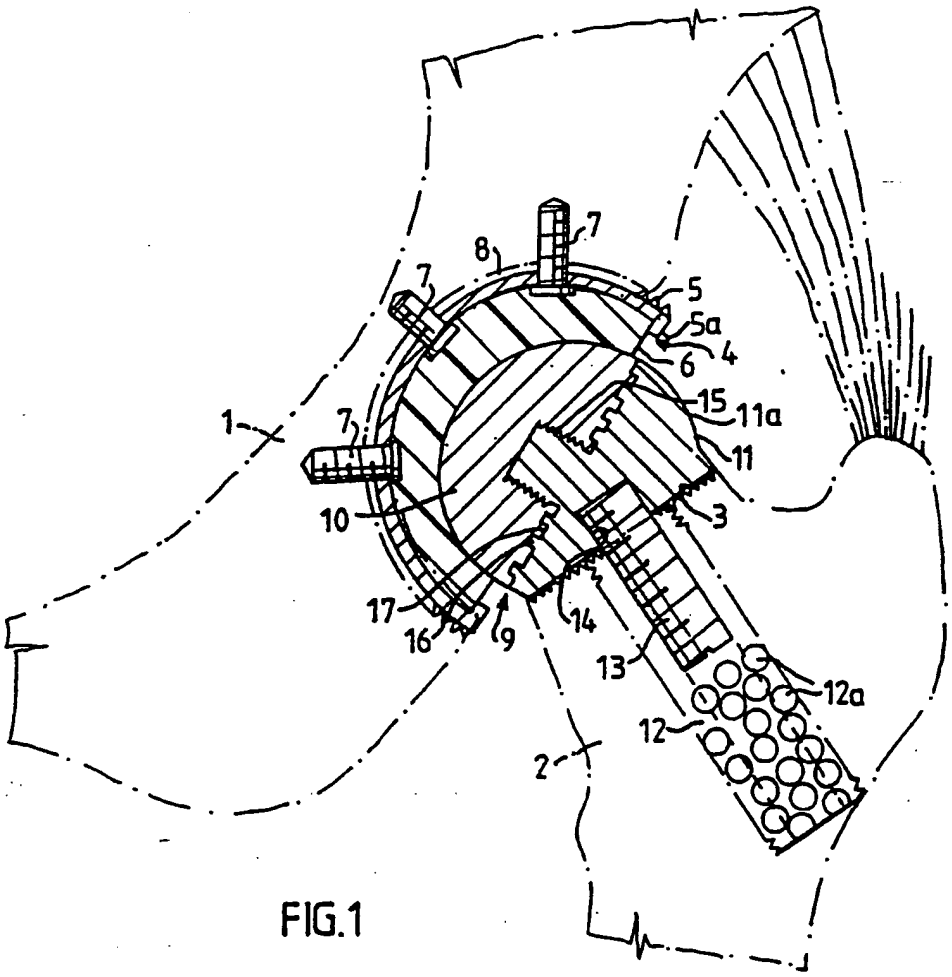

FIG.1

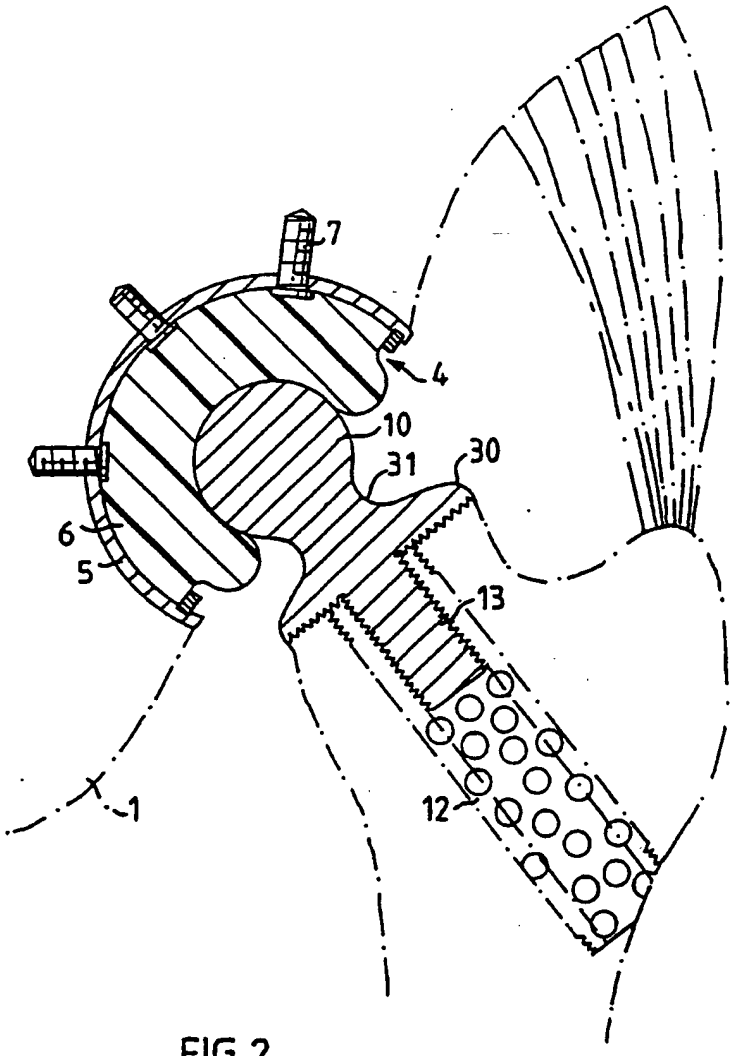

FIG.2

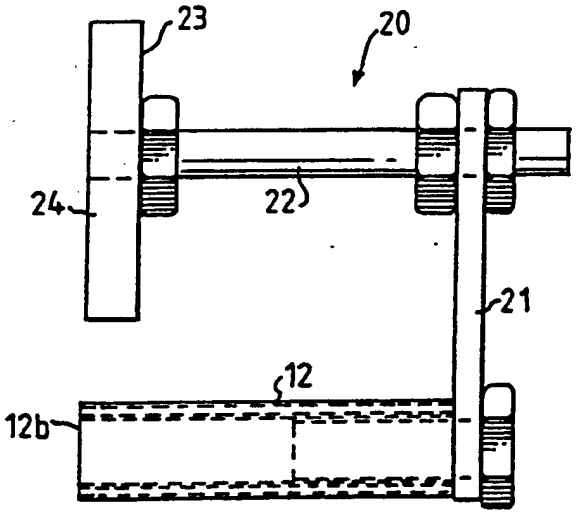

FIG.3

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 90/00794

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: A 61 F 2/32

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	A 61 F

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	US, A, 4051559 (PIFFERI) 4 October 1977, see figure 7 --	1-5,7-9
X	US, A, 4693724 (RHENTER ET AL) 15 September 1987, see the whole document --	1,2,5,7
A	EP, A1, 0010527 (LIMA S.A.S. DI CARLO LUALDI) 30 April 1980, see figures 11,12 --	10-11
A	CH, A, 568753 (OSCOBAL AG) 14 November 1975, see figure 3 --	1,7-9
A	US, A, 4332036 (SUTTER ET AL) 1 June 1982, see figure 11 --	1,5,6

* Special categories of cited documents:[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
22nd February 1991	1991 -02- 26
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Leif Karnsäter

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 4650491 (PARCHINSKI) 17 March 1987, see the whole document	1,7-9

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers....., because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers....., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

Claims 1-9: An artificial hip-joint.

Claims 10-11: A device for fixation during surgery.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the the claims. It is covered by claim numbers:

4. ☒ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 90/00794

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 91-01-31
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A- 4051559	77-10-04	DE-A-	2558446	76-07-08
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